303102

OPTICAL EFFECT OF THE CONTAMINATION OF INFRARED WINDOWS BY THE OUTGASSING OF MATERIALS IN OUTER SPACE

SEMI-ANNUAL STATUS REPORT

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E. Silberman, Principal Investigator

at

FISK UNIVERSITY

NASHVILLE, TENNESSEE 37203

I. SUMMARY OF OBJECTIVES

General research objectives for the first six months included the establishment of standard procedures for quantitative measurements of contamination-induced changes in window transmission in the middle and far infrared, and the construction and assembly of equipment necessary for these measurements.

II. WORK COMPLETED AND PRESENT STATUS

A. INSTRUMENTATION

1. An IR-11 far infrared spectrophotometer, on loan from the Astrophysics Branch of the Space Sciences Laboratory at the MSFC in Huntsville, has been moved to the Grantee's laboratory. Considerable difficulty was experienced in restoring the instrument to full operation, however, and far infrared measurements were delayed as a result. The Golay detector used in the instrument had to be factory-rebuilt twice before satisfactory operation was achieved. This prevented effective use of the instrument until May of 1974.

2. Both the IR-11 and an IR-12 infrared spectrophotometer also used in the spectral measurements have been adapted so that data may be recorded in digital form. Digital processing of the data is required, particularly in the far infrared region, to subtract background spectra and to plot spectra in a consistent format. In both the spectrophotometers, the analog signal representing the absorbance is now digitized by a Hewlett-Packard M3 Multiverter, and punched on paper tape at intervals specified by a shaft encoder mounted on the wavelength drive. The software required to interpret and plot the data has been partially completed.

3. A chamber in which to simulate window contamination has been assembled by adding an ion pump to a standard spectroscopic vacuum shroud made by Air Products and Chemicals, Inc., for its Displex series closed-cycle helium refrigerators. A Displex CS-202 cryostat is being used to control subambient temperatures for the contamination experiments. The window material on which contaminant effects are to be studied is mounted on the internal cold-finger

of the Displex, where the temperature can be set anywhere from 300 to 20 degrees Kelvin. The shroud had five aperatures, of which four are used. Two are outfitted with appropriate windows for the infrared transmission measurements, one port has a needle valve for controlling sample deposition rates, and a fourth has a quartz window to allow for ultraviolet irradiation of the sample. A 150 watt Xenon lamp powered by an Oriel power supply is used to supply the UV radiation for simulated solar exposure experiments.

B. EXPERIMENTAL

1. The full infrared absorption spectra of solid films of water and ethanol have been measured from 4000-35 cm^{-1}. These measurements were made principally to allow us to develop systematic procedures and to test the experimental instrumentation. The spectra were obtained at several different temperatures and from films prepared at different depostion rates to establish the effect that these varying conditions would have on the two simulated contaminants. The measurements were obtained using two deposition substrates, cesium iodide and linear polyethylene. In the case of ethanol, ultraviolet irradiation of the sold film has been tried for short periods, but no apparant change in the structure of the film has so far been observed.

2. In order to gauge contaminant film thicknesses from their absorption spectra, a procedure has been developed in which an independent measure of film thickness is obtained by multiple reflection interference fringes as observed in a laser beam reflected from the film during the deposition period. A working curve can then be constructed which relates the absorbance of specific contaminant bands to deposit thickness.

III. WORK IN PROGRESS

With the necessary preliminary work largely completed, data will now be accumulated for contaminants of particular interest which will be deposited on window materials likely to be used in a space environment. Detectability limits for possible contaminant films will be established with regard to their middle and far infrared absorption spectra. Each sample will be also examined

to determine its sensitivity to chemical change at low temperatures during exposure to ultraviolet radiation.